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Siding and Continuous Foam Insulation

From The Editor . . .

We live in complex communities that require some degree of community level governance of our activities. We create codes and standards to place limits on our behaviour. Usually the regulations are drafted by government and apply to everyone. The specifics of standards are drafted by groups of stakeholders that include members of industry, specialists, users and public servants.

The intent of most regulations is to set out minimum safety or performance criteria. Sometimes they focus on the safety of a select group of users, others on the whole community.

Some folks may question the need for any regulations, others want more. There is always a fine line. At the end of the day, we need some of these in order to protect ourselves from ourselves, others so that everyone has a baseline from which to work.

Just because regulations and standards have been implemented, no matter how simple or complex, not everyone will agree with them or follow them. Even the best regulations don't mean much unless everyone complies with them. That is why when we have regulations we need to have someone to do oversight - police to enforce criminal and traffic regulations, health inspectors to inspect sanitary conditions, electrical or plumbing inspectors, or building inspectors to inspect code compliance, and so on.

No matter how well defined the standard may be, there usually needs to be some interpretation. This is what courts do every day. This is what professionals often need to do. This is where the interpreters (or 'enforcers') need to use common sense and judgement.

Readers may have seen a recent news item that described the problems of an elderly gentleman in New Brunswick who built his own house. By all accounts, the house was well built. Even though it was owner-built from self-milled lumber, it was built as well as any by a professional builder using commercially acquired products.

Regrettably, it seems that the local building inspection department did not exercise much discretion when reviewing the work, nor did they give the owner any credit for the merits of the work. It seems that the use of locally milled lumber was a major issue because the lumber didn't have third-party certifications. The inspectors stuck to a very narrow interpretation of the building code rather than using common sense and observing the physical evidence in front of them.

I've often observed that when someone tries to use new materials, systems or designs, building authorities are challenged and often make it difficult. Largely, I suspect the actions are driven by lawyers in the backroom that send out the word to building officials to reduce any risk of liability. Even use of fundamental building science analysis is difficult as the authorities are afraid to even consider this – perhaps because they lack the confidence or understanding. This leads to very narrow code or regulation interpretations, as everyone sticks to the tried and true. This has the effect of discouraging innovation.

Richard Kadulski,
Editor

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Attaching Exterior Wall Cladding Through Continuous Foam Insulation

Residential construction practices have been improving over the past number of years in terms of structural performance, however, there is much room to improve the thermal performance of conventional wood framing. Standard construction practices need to be modified in order to attain higher performance, especially to address thermal bridging across the framing.

Innovative designers and builders have been finding ways to build with more energy efficient construction details. Now changes to building codes are being introduced in an effort to improve energy efficiency in the building stock. Higher performance requirements, along with a deliberate move towards the use of effective insulation calculations, rather than nominal insulation values, will mean that changes to current construction practices will become mainstream.

Conventional wood frame construction results in quite low effective performance, because the wood framing creates a significant amount of thermal bridging. The R-value of framing lumber, depending on species, is about 1 – 1.25/inch thickness. Thus a 2x6 wood stud has an R-value of about 6.5, while the adjoining cavity can be insulated to the full depth, and depending on type of insulation used, can have about R-20 (if fiberglass batts) up to about R-30 (if medium density spray foam insulation). Because the framing can account for 20 to 25% of the wall surface area, the effective thermal insulation of the wall insulation, when the surface areas are averaged, will be much less.

New code requirements for improved energy efficient construction, as well as the renewed interest in high performance programs such as R-2000, Energy Star, Built-Green, and Novoclimat will result in increased use of continuous insulation such as rigid foam wall sheathing. Depending on the building design, location, and energy design criteria requirements, foam insulation thicknesses will also increase.

Until recently, most code requirements for insulation were done simply by reference to the nominal insulation levels in the assembly, rather than the effective R-value. This is now changing, and new energy codes are requiring the use of effective R-values. The calculations done with HOT-2000 for Energuide labelling and for various energy efficiency programs have already been using the effective R-values.

The use of increased thickness of foam sheathing on walls and behind cladding to meet higher energy code requirements calls for improved solutions to attach wall covering assemblies (i.e., cladding, furring, etc.) through the foam to the structural element. These connections must support the weight of the cladding and secure the cladding to the wall to resist wind and even seismic forces. So the question becomes, "How does one design the attachments for cladding materials through foam sheathing?"

The challenge has been how to structurally attach exterior claddings over continuous exterior rigid insulation while avoiding thermal bridging. This becomes a greater challenge as thicker insulation levels are used to achieve higher performance levels or to meet more stringent effective R-value requirements.

Many siding manufacturer's installation instructions limit the thickness of continuous insulation to one inch. It is assumed that this current limitation is based on lack of knowledge of the loading on the fastener that would be incurred with greater thicknesses.

Types of Foam Sheathing

Expanded polystyrene (EPS) - rigid foam plastic insulation manufactured from expandable polystyrene resin containing a blowing agent that is exposed to steam and subsequently molded into the desired shape resulting in a closed cell structure.

Extruded polystyrene (XPS) - rigid foam plastic insulation manufactured by extrusion and expansion of polystyrene monomer, the base polymer, in the presence of a blowing agent resulting in a closed cell structure.

Polyisocyanurate or polyiso (PIR) - a closed cell, rigid thermosetting plastic foam board manufactured from a mixture of certain types of polyols and isocyanate (polymeric methyl diphenyl isocyanate or MDI) with a blowing agent that is reacted into a rigid board.

Minimum Fastening Required for Rain Screen Furring Over Foam Sheathing on Wood Framing (1 x 3 wood Furring)

Fastener Type	Min. penetration into wall framing	Fastener Spacing in Furring	Maximum Thickness of Foam Insulation					
			16" o/c stud spacing			24" o/c stud spacing		
			Max cladding weight			Max cladding weight		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Nail: 0.120" shank; 0.271" head	1 ¼"	8	4	4	1.5	4	2	1
		12	4	2	1	4	1.5	0.5
		16	4	2	0.5	4	1	DR
Nail: 0.131" shank; 0.281" diameter nail	1 ¼"	8	4	4	2	4	3	1
		12	4	3	1	4	2	.75
		16	4	2	.75	4	1.5	DR
#8 screw	1"	12	4	4	1.5	4	3	1
		16	4	3	1	4	2	.5
		24	4	2	.5	4	1	DR
DR = design required								
For cladding system weights more than 25 psf with any thickness of foam sheathing, a design professional needs to be consulted.								

Minimum Siding Fastening Required for Direct Attachment of Foam Sheathing on Wood Framing (minimum 1 ¼" penetration to wood)

Siding Fastener Type	Siding Fastener Vertical Spacing	Maximum Thickness of Foam Insulation					
		16" o/c stud spacing			24" o/c stud spacing		
		Max cladding weight			Max cladding weight		
		3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
0.113" diameter nail	6	4	3	1	4	2	.75
	8	4	2	.75	4	1.5	DR
	12	4	1.5	DR	3	.75	DR
0.120" diameter nail	6	4	3	1.5	4	2	.75
	8	4	2	1	4	1.5	.5
	12	4	1.5	.5	3	1	DR
0.131" diameter nail	6	4	4	1.5	4	3	1
	8	4	3	1	4	2	.75
	12	4	2	.75	4	1	DR
DR = Design required							
For cladding system weights more than 25 psf with any thickness of foam sheathing, a design professional needs to be consulted.							

Foam insulation manufacturers in the US have created the Foam Sheathing Coalition to focus on common issues such as addressing solutions to building code issues and promoting the proper technical use of foam sheathing.

Over the past few years they have been funding research related to the use of foam sheathing, not only insulation and moisture issues, but also the structural concerns related to the use of insulating sheathing products. Analysis has been done by tests as well as engineering calculations, with special focus on the fasteners that are expected to carry the exterior siding loads.

A major concern with the use of foam sheathing is that the exterior cladding is moved out from the structure so the fasteners carrying the cladding may in effect be cantilevered from the structure, and be required to carry a greater load.

Fastener choice is dependent on the weight of the cladding material to be attached to the building. The table below contains the weights of common siding materials.

It was found during testing that the connection strength was higher for greater foam thicknesses when compared to the same fastener without any foam. Important factors that affect the perform-

Siding Material Weights

Siding Material	Typical Weight of Siding Material (psf)
Vinyl Siding	1.4-1.6
Fiber Cement	2.3
Wood Lap	2.5-3.1
Direct Adhered Brick and Stone Veneer	9.0-15.0
Anchored Brick and Stone Veneer	47.0
Stucco	10.4

ance are the washer on the fastener that distributes and transfers loads, and how tightly the fastener is installed so that there is good compression of the foam board.

Generally, nails are acceptable if some type of wood-based surface is used over or under the exterior insulation. Oriented strand board (OSB) sheathing and wood furring strips should be investigated. Screws are generally the preferred method for attaching cladding or furring strips to steel-framed walls.

Codes have historically left much of the prescriptive requirements for siding attachment to manufacturers' installation recommendations. Only recently have codes begun to question whether all applicable loads were being addressed.

Further, the recommendations of manufacturers and code requirements have developed over the years based mostly on experience. These recommendations were never intended to apply to the more recently developed assemblies with thick layers of exterior continuous insulation.

The load bearing capacity of any screw or nail depends on the diameter, length, thread type, material strength, and metal gauge, and it increases with foam thickness – indicating that the assembly works as a system.✪

Guide to Attaching Exterior Wall Coverings through Foam Sheathing to Wood or Steel Wall Framing *Released September 20, 2010 www.foamsheathing.org*

The Modelled and Measured Performance of Thick Continuous Insulation Under Heavy Cladding Systems, *25th Annual RCI Convention and Trade Show, Orlando FL.*

Functions of Foam Sheathing

All foam sheathing products basically perform the same function – to improve the energy efficiency and moisture resistance of the typical framed wall with cavity insulation – along with the control of the following:

- ☞ Heat flow
- ☞ Air flow
- ☞ Rain penetration
- ☞ Water vapor flow
- ☞ Condensation

However, foam sheathing products are NOT structural sheathings. They all require some type of structural bracing solution to meet building code wall bracing requirements.

Foam Sheathing Applications

- ☞ Provides an effective means of meeting the energy code and preventing thermal "short-circuits" in the building envelope
- ☞ Easily adaptable to exceeding minimum energy efficiency requirements in voluntary "above-code" energy conservation programs such as EPA's Energy Star
- ☞ Can be detailed to provide a code-compliant water-resistive layer behind siding to simplify wall construction and prevent rainwater penetration.
- ☞ Can be specified to provide control water vapor flow and condensation potential in wall assemblies
- ☞ Adaptable to use with a variety of code-compliant structural wall bracing methods.

Global Warming Impact of Insulation

Green building is the buzz today with much attention focused on "green" environmentally appropriate materials. It seems that everyone wants to colour their product "green." The green design community has largely focused on the environmental impact of materials, and especially the embodied energy – the energy used to make the product, bring it to market, and dispose of it.

Sadly, not enough focus is given to the overall energy impact of the buildings, which over the life of a building is more significant than the embodied energy of materials. Although energy efficiency of the building is important, it is nevertheless important to ensure that construction materials not contribute to environmental degradation. One measure used for some products is the Global Warming Potential (GWP) – a measure of how much a given greenhouse gas is estimated to contribute to global warming.

The GWP is a relative value that describes the impact of different gases to trap heat in the atmosphere compared to that of carbon dioxide. It takes into account the amount of time the gases stay in the atmosphere, their rate of decay, and their ability to absorb or reflect incoming or outgoing radiation over different time periods – usually 20, 100 and 500 years – and this time interval must be stated for the GWP values to have any meaning. For most greenhouse gases, the GWP declines over time.

In June 2010, an article published in Environmental Building News (EBN) that looked at the global warming potential of insulation materials generated much discussion. The article focused on the Global Warming Potential of blowing agents used in foam insulation products, especially by closed-cell spray polyurethane foam and extruded polystyrene (XPS) relative to other insulation products. It also provided insulation material recommendations that the foam industry considers to be based on flawed analyses.

The EBN analysis was largely based on a research paper published in 2006 by Danny Harvey from the University of Toronto. Harvey's study looked at the impact that halocarbon blowing agents used in insulation products have on the environment.

A key issue is that some of the gas used in the foaming process, and which are trapped in the insulation to give it the insulating properties, diffuses out through the foam cell walls, and escapes into the atmosphere.

The EBN article raised valid points for discussion, and quickly gained the attention of a lot of folks in the industry, especially the green building community. But as often happens, there are few absolutes, lots of room for discussion and some errors or oversights.

The foam insulation industry has since challenged a number of assumptions and analyses done for the original article. There is an element of fun with numbers - numerical data can be used to prove many different things –however, there are some serious issues that have not been fully analysed, and need updating so that users can make a judgement based on up-to-date information.

Blowing Agents and Emissions Impact

The blowing agents used in the manufacture of polyurethane spray foam and XPS are an important component of these products that give them their higher insulation properties. They are also gases that can have a severe impact on green house gases.

Originally, many foam products used CFCs as the blowing agents in their manufacture, and that was switched, so that today most are using various HCFC formulations, with a much lower environmental impact.

Largely for competitive reasons, manufacturers are not always open about the specific components or chemistry of their products. Today, new blowing agents are being used. Some manufacturers are already using more benign blowing agents and some with zero ozone-depleting potential.

In addition, the way that product content is calculated needs to follow a consistent protocol, so that the results can be comparable over time and with other products. There is an ISO life-cycle analysis standard which includes a methodology to do a full cradle-to-grave analysis, which includes all aspects of producing the product such as the environmental impact of raw material extraction, transportation and processing, as well as production of the final product. In addition, these protocols establish a functional unit for each product and require an independent review by industry experts.That is why the foam insulation industry is doing an updated life-cycle analysis study and updated GWP analysis for the various products.

Baseline for Insulation Value

A long-ranging argument among insulation manufacturers, installers, designers and builders concerns the value of their respective products, and how much insulation is needed.

When insulation is added, each incremental amount of insulation will have a slightly smaller impact. For example, if you have an un-insulated wall, the first R-5 will have a big reduction in the energy consumption of the building. When the insulation goes from R-5 to R-10, the next increment will have a smaller impact on total energy consumption, and so on with added insulation. All added insulation is beneficial, but the impact is not as big.

If foam insulation is added to the exterior of a building, and the wall framing also contains insulation (typically batt insulation), the question becomes what is the impact of the extra insulation. If one assumes the batt insulation is the base case or primary insulation and the foam insulation on the exterior is a secondary incremental add-on, then the benefits attributed to the foam are not as great as if the foam insulation were the primary insulation, and the batt the additional incremental insulation.

This may seem like an obscure argument, but it is important when the effects of the materials are analysed for the good (the energy consumption reduction) and bad points (the negative environmental impacts – the GWP). It becomes a debate about which portion of the insulation is given how much credit for each.

At the end of the day, for low impact buildings, we want to reduce energy consumption as much as possible, and insulation of the building enclosure is important, as it passively provides benefits over the life of the building, without incurring ongoing maintenance or costs.

Any analysis needs to be consistent and there are ways to average both conditions. It is not entirely clear that this was done in the initial evaluations, which assumed that the foam was only a secondary insulation. The severity of the climate against which the analysis is done is also important. In more severe climate zones, the energy savings becomes a much more important factor in the equation compared to the impact in a milder climate.

Added Savings From Increased Air Tightness

Air leakage can account for 20 to 40% of a building's air leakage, which also affects heating and cooling costs.

Foam insulation products can have a major impact in reducing the air leakage of a building. In commercial buildings, exterior foam insulation is used to provide air barrier continuity, reduce thermal bridging through framing, and improve the energy efficiency.

In residential construction, exterior foam insulation is increasingly used to reduce thermal bridging and achieve higher performance building envelopes.

Building codes are now requiring more stringent effective insulation levels in wood-framed walls. These can be achieved by using deeper framing and thicker fibrous insulation in walls sheathed with conventional wood-based sheathings. An alternative is the use of rigid foam insulating sheathings with or without spray foam in the frame cavities to meet those same stringent insulation levels without the additional framing, fiber insulation and non-insulating sheathing. These can offer significant GWP savings when one considers the total embodied energy of all components in the construction assembly. ☼

Energy Efficiency Requirements In Building Codes

Energy Efficiency Is Not Just A Choice For The Individual Owner

The energy efficiency of a new building should not be viewed just as a matter for individual choice but as a community issue, influencing society at large and future users. Decisions on the efficiency of a new building will affect its energy consumption for many years or even its entire lifetime. Lost opportunities at the construction phase will lead to higher costs if done at a later stage and can wildly inflate the running costs for future users.

New buildings are rarely improved or renovated in the first few years. The energy efficiency of new buildings will thus directly influence the consumption for many years and they will be the standard for improvement of existing buildings, since renovation projects often aim to bring buildings up to the present standard.

Building codes are not a new invention. Many countries have a long tradition of setting rules for the construction of new buildings, often initiated in response to disasters such as a large urban fire, an epidemic or a natural catastrophe such as an earthquake. They mainly address concerns for construction safety, fire safety and occupants' health.

One of the earliest examples of building regulations is Hammurabi's law from Mesopotamia, established around 1790 BC. Among the 282 rules, which regulated every part of society, six dealt with the construction of houses and the penalties for builders.

Compared to this, energy efficiency regulation for new buildings is relatively new in most countries. Early energy efficiency requirements for buildings responded to poor insulation levels that could lead to health problems because of moisture or air infiltration.

Most regulations for energy efficiency in buildings before the oil crises of 1973/74 are from northern regions that experience cold winters, where the climate can affect public health. Requirements for construction with some thermal insulation first appeared during the period between the two World Wars.

Today, energy efficiency regulations are also seen as a driver for rehabilitation of existing buildings. Energy labelling systems, such as EnerGuide, allow new and existing buildings to be compared. While this is largely voluntary in Canada, it is now mandatory in most member states of the European Union.

What we are seeing in Canada is the introduction of more stringent energy efficiency regulations through building codes. Ontario, Nova Scotia, and BC have particularly aggressive targets, aiming to have requirements so that average new homes would achieve a rating of about 80. The National Building Code of Canada is currently developing new energy efficiency regulations with similar targets. The NBC proposed changes are to be published for public review in the fall of 2011, with a goal of being introduced as a code change in 2012.

High performance requirements are fine, but the industry must be able to deliver them. This was a key point when the R-2000 program was first launched in 1982. It was recognized from the outset that it made no sense to set out stringent new criteria for energy efficiency if the industry was not able to deliver the intended outcome. That is why builder training became a keystone of the program.

If significant new energy efficiency criteria are mandated, they must be buildable by everyone, and all relevant sectors of the industry, including designers, building officials and suppliers, must understand the intent and how they are to be implemented. Otherwise, the intended results could fall far short of the goals, as has been the case in the City of Vancouver.

The Vancouver Experience

The City of Vancouver issues its own building code, which essentially is the National Building Code with some local changes. However, the City's energy efficiency standards are quite aggressive for a mild climate. These include all exterior walls (above and below grade) to be insulated with R-22 nominal, ceilings R-40, Energy Star windows (U-value of 2.00 W/K.m^2), R-12 full slab insulation (whether slab-on-grade, crawlspace or basement), insulated hot water piping, mandatory heat recovery ventilators, and mandatory EnerGuide rating prior to occupancy.

When the regulations were first drafted, the thinking was that on average new houses should rate about 80 on the EnerGuide scale, although there was no requirement that houses need to meet any specific target. In effect, the city has been data mining to see what standard newly built houses achieve.

It has been a bit more than two years since the regulations were introduced. The city recently did a follow-up study to review the current state of construction. It gives a very good snapshot of current construction practices in the region as all houses have had to be tested and most builders were really unaware of the need for the testing until the house was completed.

The average rating for all houses was 76. A small number of houses achieved 80 or more, while some were less than 66. This compares to average new houses built to the current BC Building Code, which does not have as stringent prescritive requirements, although the code sets a target of 77. The average new BC house is at about 74.

A significant contributor to the lower than expected ratings is that new houses in the area are not built airtight – the average Vancouver house tests at 4.84 air changes at 50 Pascals. Although some houses had air leakage in the 1.5 air change range, others had air leakage rates as high as 11 air changes. This is much leakier than the average Canadian new house which comes in at less than 3 air changes. On the prairies, new houses are around 2 air changes.

Another factor is that many houses use gas-fired boilers which have a lower efficiency than gas furnaces and most are still B-vented (in other words, they are not sealed combustion units), which must also have an open combustion air duct.

One requirement that wasn't discussed in the City's evaluation report was about heat recovery ventilators that the City has mandated. Since most houses are not airtight, HRVs don't provide much benefit, assuming they will be operated.

An observation we've noted in our work in the city is that many HRVs are installed incorrectly, and will not operate as intended, assuming they are turned on in the first place. The residential mechanical industry was not ready for the mandatory requirement of HRVs – only a portion of the industry is qualified and competent to properly install and commission HRVs.

It doesn't help that there is no inspection of their installation. City inspectors only seem to check whether there is an HRV or not, and not whether it is installed correctly. Common problems with HRVs we've observed include uninsulated cold air ducts to the unit, drains not hooked up (and no readily accessible drains nearby), units hard connected to the structure (so that mechanical vibration is audible), the HRV located outside the heated envelope of the house, and questionable location of air inlets. ☼

Building Code Development

Canada has some of the best construction standards in the world with a high degree of uniformity in building construction and fire safety across the country.

Canada's centralized system for model code development and maintenance began in the 1930s, with the first edition of the National Building Code of Canada (NBC) being published in 1941. The Code has been developed and maintained through a consensus-based representative industry committee process and extensive public review. Code content is continuously evolving to accommodate new technologies, materials, construction practices, research, social policy and the changing needs of society, setting out minimum acceptable standards.

Development of codes and standards is not something that is done on a whim or to serve special interests, without review and analysis. A common process – from the initial proposing and consideration of code change requests to the publication of approved changes – is followed for all codes.

Any proposed change requires analysis to ensure there is a technical merit and that the new criteria need to be regulated. Its effectiveness at meeting the objectives is analysed, as are the

costs and benefits, which should match or exceed the cost to implement.

The focus of the National Building Code up to now has been concerned with health, safety, and the protection of buildings or facilities from fire and water damage.

There was a feeling until recently that energy efficiency does not belong in the building code. However, with changing societal attitudes, there is a sense that codes should address other issues – in particular resource and energy efficiency. That is why new code objectives are being introduced for water conservation and energy efficiency.

In the 1990s separate documents were developed to complement the building code to address the energy efficiency of new construction. The Model National Energy Code for Buildings (MNECB) and the Model National Energy Code for Houses (MNECH) were designed to complement the building codes. They set out minimum requirements for energy efficiency that could be adopted in whole or in part into provincial or territorial codes or, alternatively, used as guidelines for the construction of energy- efficient new buildings. However, these were not widely adopted, although the MNECB was used as a reference for various energy programs, while the MNECH was not used at all.

A need to update the MNECB was identified. It has undergone a review so that it is now in the same objective-based format as the National Building Code. It sets out updated minimum requirements for features of buildings that determine their energy efficiency, taking into account regional construction costs, regional heating fuel types and costs and regional climatic differences.

The MNECB has been available for public review until the end of November, so that Code users and stakeholders could review the new objectives, functional statements, and proposed technical changes, and provide comments on each. The public comments will now be assessed. The code committees have to determine whether the changes should be approved, altered or rejected.

It has been decided that rather than update the MNECH, which applies to small residential and commercial buildings (houses and small buildings with a footprint no larger than 600 m^2) that fall under Part 9 of the NBC will be incorporated into the National Building Code as a new section in Part 9 of the code (tentatively 9.36). It is expected that the draft technical requirements will be ready for public review in the fall of 2011, with final publication of the requirements as interim changes to the NBC in the fall of 2012.

The energy targets for the MNECB committee were to achieve an energy performance that would result in buildings that on average consume at least 25% less energy than in the previous edition of the code. The energy targets for Part 9 (houses and small buildings) were set to develop requirements so that houses would achieve an energy performance that on average would be the same as a house with an EnerGuide rating of about 80. The targets were set by provincial and territorial governments.

The review and development of new code requirements is not being done in isolation by the codes centre and its committees. They rely on all sectors of the industry for input and review, to ensure that proposed changes are meaningful, will provide net benefits, and be able to be implemented. Much reliance is placed on groups and agencies that have the expertise to contribute. And when the changes are ready, they are available for anyone to comment.

R-2000

For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000
www.R-2000.ca

NRCan's Contribution to Code Development

Code development requires data and data analysis – to know where industry is at, what is possible, and to analyse the impact of potential changes to standards.

An invaluable resource to the energy codes development process is the contribution being made by Natural Resources Canada (NRCan). Their mandate is to strengthen and expand energy conservation, energy efficiency and enhance the responsible development and use of Canada's natural resources. Backed by research at NRCan and external labs, they help to develop energy efficiency standards for energy consuming equipment.

NRCan has been involved with housing programs since the late 1970s through various energy efficiency and renewable energy initiatives. Experience gained through research and demonstration projects is put to use by builders, manufacturers and regulatory officials. Perhaps the highest profile and widely known initiatives for the residential construction industry are the R-2000, EnerGuide and ecoEnergy programs. These have not only created energy performance evaluation tools and standards, but have also included training for professionals, monitoring, awards and publications to raise awareness. They have helped to stimulate innovation and open minds to new possibilities to achieve higher performance equipment and construction.

The information that has been collected by the EnerGuide rating service provides a comprehensive snapshot of Canadian housing. With more than 800,000 houses in the database, it is the most comprehensive national housing database in the world. It has been a valuable source of information for the energy code development committees. This means that the costs and benefits of any proposed energy efficiency upgrades can be directly assessed against current construction practices.

Great Canadian Reno-Demo 2.0

Long-time readers may recall that in 1994 we documented a renovation to your editor's home – a modest early 20th century North Vancouver home. The renovation incorporated the development of a secondary suite – the first in the region.

The work provided an opportunity to incorporate and showcase the latest technologies for energy efficiency – a number of which had been showcased in the Advanced Houses demonstration program that had been initiated by NRCan with the participation of CHBA in 1993.

The original work dealt with the ground floor (basement level) and the remainder of the house was essentially left untouched, as a separate suite.

After a number of years, the time has come to complete the updating and renovation of the rest of the house, along with a small addition to make better use of the space in the house.

Although the city doesn't have any records when the house was built, since it may predate accurate records, we did uncover a number of 1922 newspapers on the interior in the walls.

The EnerGuide rating for the house at the start of the work was 58 – a relatively respectable value for a house of its vintage, especially since a number of the windows were still the original single-glazed units, the house had a measured air leakage rate of 11.88 air changes at 50 Pascals, and an equivalent leakage area of 2630 cm^2 (2.8 sq.ft.), and mininal insulation.

The proposed work should bring the EnerGuide rating to about 83. It will include exterior rigid insulation for extra insulation and as an exterior air barrier, new triple-glazed, double low-e windows, and air sealing. We'll document the progress in the coming issues.

As any renovator understands, the start of a project can be full of surprises. What seemed like a relative modest addition and renovation, started with the discovery that asbestos was widely used as early as the early 1920s.

Asbestos was found in the plaster base coat – which was the interior finish throughout most of the house. Consequently, the preparatory demolition work became a wholesale gut of the house by the men in suits, as they toiled for three weeks after sealing the house and stripping everything from the interior. As a result, the original framing was exposed – it showed a modest amount of advanced framing (single top plate), but otherwise sub-standard framing practices, which included 2x3 studs supporting the main bearing wall and 2x6 floor joists spanning 12 feet. (Somehow the movie The Money Pit comes to mind).

Other surprises were the discovery of rot in a few areas (not unusual for a wood frame house of its vintage), the lack of proper foundations (although the house has stood for ninety years now), and original electrical wiring.

Framing work has begun, and in future issues we'll report on the progress, and what technologies are being used.

Canadian Home Builders' Association

Technical Research Committee News

Manitoba Building Code Changes Mandate HRVs

Manitoba has introduced changes to the Manitoba Building Code. The changes now require energy efficient balanced ventilation, and require the use of heat recovery ventilators. The minimum efficiency for HRVs is 60% (measured at 0°C) and 62% (measured at -25°C). These levels are even higher than the recently established Energy Star levels for HRVs.

The changes were made with the realization that only a portion of the HRVs currently on the market can comply.

In addition the code has set the minimum energy efficiency for natural gas and propane furnaces at 94%.

The window requirements now call for double-glazed, low-e windows with insulated spacers.

Energy Star Gas Furnace Standards

Energy Star qualifications for gas-fired furnaces are no longer recognized in Canada until a new more stringent Energy Star specification is finalized.

In Canada, natural gas-fired furnaces must meet Canada's Energy Efficiency Regulations before they can qualify for the Energy Star symbol in Canada. Under the Energy Efficiency Regulations, the AFUE performance level for gas-fired furnaces was raised to 90% effective January 1, 2010, which was the criteria for qualifying for Energy Star. As a result, the Energy Star specification for gas-fired furnaces is currently under review. The proposed criteria for Energy Star gas furnaces is to raise it to 94% AFUE.

Energy Star is the international symbol of premium energy efficiency. In Canada, Natural Resources Canada promotes the Energy Star symbol in Canada and monitors its use.

Products that display the Energy Star symbol must have been tested according to prescribed procedures and meet or exceed higher energy efficiency levels without compromising performance. Standards are set to recognize the top 25% models of a product class.

As market penetration of energy efficient equipment increases, the requirements for qualifying for Energy Star are revised. In the US it is estimated that the current market share for Energy Star qualified gas furnaces is 43%. That is why the Energy Star criteria for gas furnaces are being revised. The proposed Energy Star criteria will combine AFUE levels along with fan efficiency and furnace cabinet air leakage requirements.

Energy Star for Heat Recovery Ventilators

Canadian Energy Star criteria have been developed for residential heat recovery and energy recovery ventilators, and became effective January 1, 2010. In order to qualify as Energy Star, a residential HRV must have a capacity of less than 500 cfm and comply with testing and performance requirements. HRVs with electric resistance heaters are ineligible for ENERGY STAR qualification.

Products to be sold as Energy Star qualified must be tested and meet minimum Sensible heat-recovery efficiency (SRE) requirements measured at 0 °C (32°F) and -25 °C (-13 °F). They must take into account fan energy use, the leakage (exhaust air transfer), flow imbalance, frost control, and external and internal energy gains and losses. The net supply airflows (in cfm) used during testing at these two different temperatures must be within 10% of each other, and specified in product literature and labelling.

Tests must be done in accordance with CSA C439 (Standard Laboratory Methods Of Test For Rating The Performance Of Heat/Energy-Recovery Ventilators) and must be certified by HVI or another organization approved by NRCan. Certification testing includes both initial qualification testing, as well as ongoing verification testing.

The Energy Star criteria include requirements for installation instructions and consumer information. The label for Canada must include a statement that says "This product earned the ENERGY STAR® by meeting strict energy efficiency guidelines set by Natural Resources Canada and the US EPA. It meets ENERGY STAR requirements only when used in Canada."

Minimum Requirements for (Canadian) Energy Star HRVs			
Minimum Sensible heat-recovery efficiency (SRE)		Minimum Fan Efficacy with 0°C (32°F) Supply Temperature	
at 0°C (32°F)	at -25°C (-13°F)	SRE < 75%	1 cfm/W (0.47 L/s/W)
60%	55%	SRE ≥ 75%	any cfm/W (L/s/W)

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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New Residential Sheet Metal Installer Trade

Heating systems for low-rise residential construction must be designed and installed properly. The challenge for the residential construction industry has been that there has not been consistent training or certification of residential heating system technicians although there have been attempts to introduce training and certification for these trades.

TECA (Thermal Environmental Comfort Association), a BC-based mechanical industry trade association, has spearheaded the development of a Certified Heating Technician program in BC. The Industry Training Authority of BC now has a Certificate of Qualification for Domestic/Residential Certified Heating Technicians (with endorsements for Forced Air or Hydronic systems). It is issued to persons who successfully complete the training program that was developed with the participation of industry.

"Domestic/Residential Certified Heating Technician" means a person who performs tasks in the residential market dealing with the design, installation and servicing of heating, ventilation and cooling systems through forced air or hydronic means.

Now Ontario is proposing a new low-rise residential sheet metal installer trade certificate. The new trade would be a separate branch of the existing sheet metal worker trade, which is defined by regulations under the Ontario Trade Qualification and Apprenticeship Act, and would be deemed a compulsory trade.

The scope of the new residential trade will cover residential sheet metal air handling and ventilation systems. It will apply to low velocity air systems that do not penetrate any fire-rated separations, with a maximum airflow of 2000 cfm and a static pressure of no more than 1 inch water column or high velocity air systems with a maximum air flow of 2500 cfm and a static pressure of 3 inches.

The Ontario apprenticeship training program would consist of three periods of 1,500 hours each.

2010 National Building Codes Now Available

The 2010 editions of National Building Code, National Fire Code and National Plumbing Code are now available. These codes incorporate nearly 800 technical changes, addressing the many technological advances and health and safety concerns raised since the release of the 2005 editions. Available in Softcover or Binder formats.

They can be ordered on-line from the National Research Council of Canada (NRC).
www.nrc-cnrc.gc.ca/eng/virtual-store/index.html

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A limited number of back issues are available, at a special price of $5.75 each (plus 12% HST).

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You Asked Us:
About Insulation In An Exterior Wall

I am trying to build a super insulated house within the constraints of a tight budget and a relatively remote location 100 miles from Whitehorse. I want to work with fiberglass batts and sheets for insulation. The design I am leaning towards raises three questions that I hope you can answer.

1. Manufacturers indicate that the R-value of fiberglass batts is maximized when batts are at their full rated thickness, i.e. 6" for R-20, but I intuitively feel that there is a benefit in compressing the batts. Your article on Wall Energy Ratings (Solplan Review, April 2010) mentions that effective insulation value is reduced by air infiltration. Can the overall performance be improved by compressing the batts into a smaller space, say 5" for R20?

A. Batt insulation materials are designed for their application and performance value. Compressing a batt will decrease the thermal insulation value.

Information prepared by Owens Corning shows that a standard 5 ½" thick batt with an R-19 rating when compressed into a 2x4 cavity will have an R-value of 13. Similarly a 6 ¾" R-22 batt compressed into a 2x4 cavity would be R-14.

Manufacturers are now making a range of products with varying insulation levels. 5 ½" thick fiberglass batts are now available with R-values of 20, 22, and 24. You just pick what you want.

Air infiltration does affect the performance of the insulation and the whole assembly. However, it is not necessarily the nature of the material, but how it is installed that will determine whether the full insulation value is achieved, and how the air barrier installation is detailed. The way that fibrous materials are installed often leaves something to be desired, with gaps through which air currents can be generated, resulting in a degradation of the insulating value.

The more critical aspect for improving the thermal performance of a wall is how you address thermal bridging through the framing. For a conventional stud wall, the most effective way to improve the thermal value is installing rigid insulation across the exterior framing. The alternative would be a double stud wall to accommodate more layers of insulation.

2. Is it OK to install foam board inside a wall cavity? I am thinking of installing 1" Energy Shield foil covered polyisocyanurate on the inner surface of the exterior studs where it will serve as my air and vapour barrier. Will I have condensation problems with R18 outside my AVB and R-32 inside?

Our proposed assembly is:

- Siding over sheathing paper on plywood sheathing
- 2 x 4 framing @ 16" o/c with R-12 batt insulation;
- 1" (or 1 ½") Energy Shield (Polyisocyanurate), caulked and taped;
- 5" space filled with R-20 batts; and an inner 2 x 4 @ 16" o/c wall with R-12 batts

A. Rigid foam board can be installed inside or outside the wall. Most of the time the foam is installed on the exterior because it is easier, and you are not dealing with issues such as details at junctions of interior walls to the exterior. Unless the foam is continuous, you would end up with significant thermal bridging.

It is always important to review the location of the vapour barrier – especially if you place it within the wall. The National Building code has a table (Table A 9.25.1.2.A) that sets out safe ratios of insulation outboard to inboard of the vapour barrier. In Solplan Review No. 142 (September 2008) we had an item on this issue, and how this is calculated.

The number is dependent on the severity of the climate. In a mild climate like Vancouver's, it is acceptable to have a vapour barrier quite far out into the wall, but in a very cold climate, the vapour barrier has to be closer to the interior. As long as you are within the ratio allowed, and the building enclosure is airtight, there should be little potential for condensation or moisture problems.

The construction assembly you describe has a ratio of 0.56, so should be acceptable in your region, since the Yukon climate has a range of 6900 to 8700 degree days below 18°C. In a climate with 7,000 to 8,000 degree days, the minimum ratio is 0.40.

3. I don't understand how the housewraps have cornered the market. If I have a good air barrier inside my wall do I need to spend extra time and money on a sealed air barrier on the outside, as opposed to tarpaper with lapped joints?

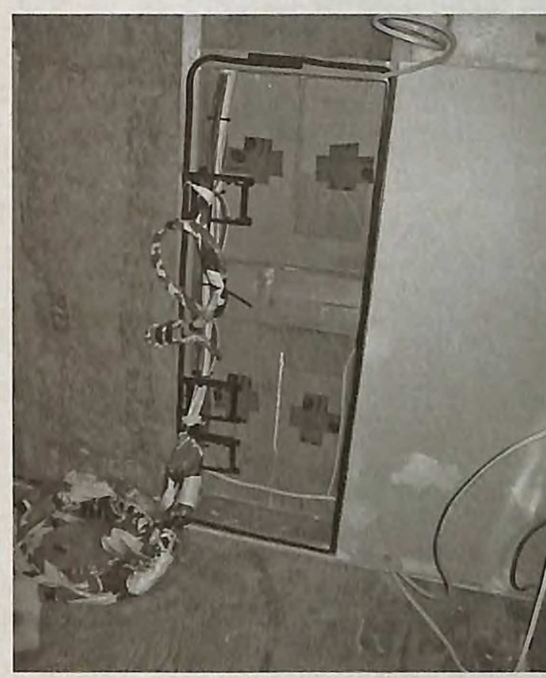
A. The housewraps typically perform two functions – one is as the weather barrier, and the second is as an air barrier.

The ***weather barrier*** *is there to deal with moisture that might penetrate the exterior cladding. It can be a housewrap, or it can be the more traditional sheathing paper.*

The ***air barrier*** *is there to minimize air leakage through the building enclosure and can be applied either inside or outside. An exterior housewrap offers one way to provide an air barrier. Especially with simpler house designs the exterior wrap can be done easily with fewer penetrations than on the interior, making it easier to seal. However, the housewrap must be installed carefully, with attention to sealing details in order to provide the continuous air seal.*

K.A.
Haines Junction, Yukon

Construction in the Digital Age



Today we expect our homes to be wired for a variety of new systems - entertainment, security, and home automation. Our homes increasingly have more cables and wires for a multitude of options, some to be installed immediately, others as pre-wire for future applications.

The challenge for builders becomes what to do with the wires, and how to maintain the integrity of an airtight building enclosure. This is especially more complicated because unlike electrical outlets, there are few requirements for boxes or housings for the terminations of the cables.

Jonathan Zerkee, a builder in BC's Fraser Valley has come up with a very tidy solution for the spider's web of cables we see so often today. For those areas where there is a concentration of cables and plug-ins, he has built a super box using extruded polystyrene insulation at the back of the 'box', and then carefully caulked and sealed all connections to the framing and cable penetrations. The gasket on the face is for air sealing to the drywall – he normally uses the airtight drywall approach for the interior air barrier, relying on vapour barrier paint to provide the required vapour barrier. ☼

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Energy Answers

Rob Dumont

What should Canada be doing in revising its National Energy Codes for Residences and Buildings?

Recently Canada lost its bid for a seat on the prestigious Security Council of the United Nations. Part of the reason was our refusal to behave responsibly and take serious action against climate change. In life, if you want to be respected, you must do respectable things.

Building energy use is a major, major component of our total energy use. According to the ASHRAE treasurer in a recent speech to the Building Green Saskatchewan Conference in Regina in October 2010, buildings account for 40% of all energy use in the United States, and the buildings sector exceeds the transportation sector and the industrial sector.

A sustainable world will not be without sustainable buildings.

Canada has been a consistent laggard in the fight against climate change. This laggard behaviour is not the action of just one political party at the federal level. Both the current Conservatives and the previous Liberals did very little to address climate change. By contrast, most European nations aggressively pursued the Kyoto goal. Canada will miss the 2012 Kyoto Goal of a 6% reduction in energy use compared with 1990 by as much as 40%.

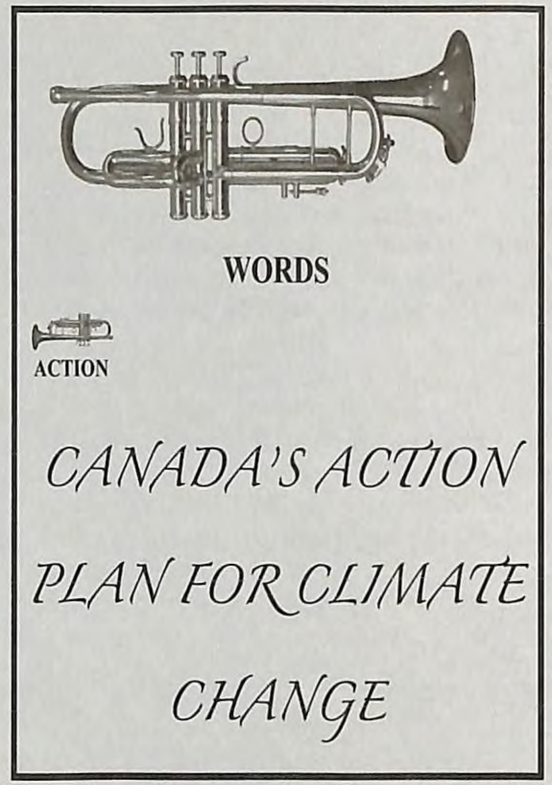
While Canada's emissions have soared, Germany had chopped its greenhouse gas emissions by 18% as of 2006 compared with 1990, while the UK reduced its emissions by 15%. Canada, in shocking contrast, had increased its emissions by 33.8% over the same period according to Environment Canada numbers. This is shameful behaviour on Canada's part.

As of 2006, Europe was averaging greenhouse gas emissions of 10.6 tonnes per capita per year, while Canada was using 23.2 tonnes or 119% more than Europeans.

Andrew Weaver, a climatologist at the University of Victoria, put it well: "We're laggards and obstructionists."

The cartoon says it all.

Other nations and jurisdictions are aggressively upgrading their minimum standards for energy efficiency. In the United Kingdom, all new houses built after 2016 will have to be net zero energy consumers.



What specific policies would you recommend for new buildings?

It is almost always less expensive to build new buildings to a higher energy standard than to retrofit them later. Upgrading wall insulation after the fact is very expensive, as adding more insulation to the walls of an existing building almost always entails changing the finish on either the inside or outside of the wall. For this reason, I am proposing the following real action plan:

1. All new residences in this country must have a minimum of R40 insulation in the walls as of 2012. Full stop. Canada is one of the coldest countries in the world, and yet our wall insulation values for new construction are set assuming that cheap energy and a limitless atmosphere to absorb carbon dioxide emissions will always be with us. (Sweden increased its minimum wall insulation value to R33.5 over 25 years ago.[1]) Attic, basement wall and window insulation values should be correspondingly increased. A maximum air leakage rate of 0.75 air changes per hour at 50 pascals should be set for all new houses, and all new houses should have a heat recovery ventilator with a minimum effectiveness of 75%

2. By 2016, all new houses in this country must be net zero ready. By net zero ready, I mean that they should be well enough insulated, sealed and with an HRV so that at a later date they could be energized by on-site solar thermal and solar photovoltaic panels.

An even more stringent policy is in place in the United Kingdom, which requires that all new housing be Net Zero (and not Net Zero Ready) as of 2016.

Who would pay for the extra costs of this initiative? I estimate that the 2016 standard would cost an extra $4 billion dollars a year. This is small compared with the annual budget revenues of the federal government of $274 billion as of 2009-2010. If half of the costs were covered by the federal government, the incremental cost would be less than 1% of federal government revenues. The remaining costs could be covered by provincial governments, utilities and homeowners.

The current proposed revisions to the energy part of the National Building Code of Canada are very disappointing. Although Canada has roughly the same population as California, we do not have the same mild climate. Why are we building houses to the same insulation standards?

Reference:

1. *Energy in the Built Environment, Swedish Council for Building Research, Svensk Byggtjanst, Box 7852, S-1033 99, Stockholm, Sweden*

Safe Handling of Ethanol and Ethanol-Water Mixtures in Geothermal Loops

The Ontario Ministry of Labour has noted safety incidents concerning the use of ethanol in geothermal pump installations. As a result, HRAI has issued a hazard alert to make their industry members aware of the issue.

Due to environmental concerns, a growing number of geothermal systems are using an ethanol water mixture as an alternative to glycol for the heat exchange fluid in the ground loop. Ethanol-water mixtures as low as 20% ethanol in the total system volume are classified as Class IC flammable liquids. The vapours are ignitable in the presence of an ignition source that is capable of raising the vapour temperature above the ignition point.

In one documented case, which involved the flushing of an installed geothermal system, ethanol and water were mixed in the basement of a home. During the process, some of the mixture spilled onto the basement floor and the vapours were ignited by an ignition source in the basement, resulting in a fire.

Anyone working with geothermal systems must be aware of the hazards associated with the use of ethanol-water mixtures, including installers, maintenance personnel, and designers.

Basic safety precautions for ethanol-water mixtures should include (but not be limited to):

- Safe dispensing of ethanol and ethanol-water mixes during the flushing process as per requirements of applicable regulations.
- Storage of ethanol and ethanol-water mixtures must meet the requirements of applicable codes for fire prevention protection.
- The equipment in the vicinity of the flammable liquid must meet the requirements of the provincial electrical code for use near flammable liquids.
- All sources of ignition must be at least 3 m from the ethanol or ethanol-water mixture including flush carts.
- A spill control kit and portable fire extinguisher must be provided at the location where the flammable liquid (ethanol or ethanol-water mixtures) is dispensed.
- Workers involved in the installation and service of geothermal systems must be trained on the proper use of the flammable liquid.

Use of Photoluminescent Markings for Exit Stairways in Buildings

By Noureddine Benichou and John Burrows

The National Research Council's Institute for Research in Construction has published an online guide on the installation of photoluminescent markings (PLM) in buildings and the requirements for satisfactory performance.

Photoluminescent material emits light for a length of time following excitation by light after the light source has been removed. In fire safety, the most promising uses for photoluminescent materials are safety markings such as exit signs, directional signage, door markings, pathway markings, obstruction identification and other elements that comprise a safety way-guidance system. In blackouts resulting from power failures or fires, photoluminescent safety markings in the form of paint, plastic strips and signs can aid evacuation by guiding and directing people to safer locations (Figure 1).

Figure 1. Emergency lighting (upper left) and examples of PLM guidance in the event of power failure

The markings are not designed to provide enough light to illuminate a dark egress path, but rather to provide luminescent signs and outlines of the egress path, stairs, handrails, and obstacles, so that occupants can discern these features in dark conditions. The markings are in addition to, and not a substitute for, signage required under the National Building Code of Canada.

While the guide was developed primarily for federal office buildings, it can aid in the design and installation of photoluminescent markings in other types of buildings with enclosed exit stairways as means of egress.

Dr. Noureddine Benichou is a senior research officer in the Fire Research program of the NRC Institute for Research in Construction. John Burrows is an Ottawa-based consultant and technical writer.

The guide describes the principles governing the design and application of PLM exit path markings such as:

- Continuity: Markings should be placed in a continuous and unbroken manner along the escape routes of a building.
- Visual reinforcement: PLM signs and directional indicators should be spaced in such a way as to provide consistency and continuity of information.
- Location: PLM markings are used on exit door handles or opening devices, exit door frames, leading edges of steps, landings (see Figure 2), handrails, exit signs, and obstacles. Markings should be positioned at low locations for optimum visibility in smoky conditions. Signs and indicators, which are usually located at mid-floor height or close to ceilings, should be placed so as to ensure visual reinforcement.

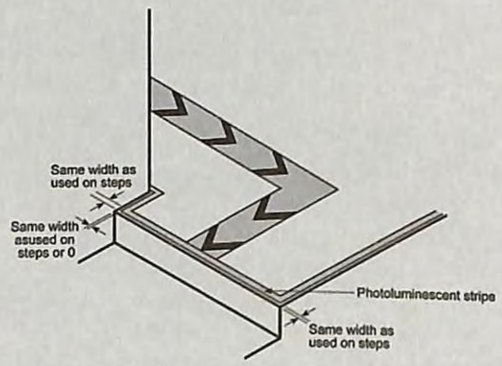


Figure 2. Example of PLM landing markings

- Visibility and colour: PLM markings should have a "safety" colour, which is usually green/yellow (the natural colour of PLM pigments). They should also have the appropriate luminance and contrast with the surrounding environment.
- Destination: Markings should clearly indicate intermediary and final destinations along the escape route.
- Avoidance of confusion at decision points: PLM markings and signs should be placed so that the designated route is clear and there is no ambiguity that could lead to uncertainty or confusion during evacuation.
- Dead ends: Markings and signs should direct evacuees away from dead ends toward designated places of safety.
- Multi-storey buildings: Every storey should have a floor plan made with PLM to help with directions and orientation.
- Firefighting and emergency equipment: All firefighting and emergency equipment should be marked with appropriate PLM signs. These signs and markings provide additional visual orientation cues to occupants and information to firefighters.

The guide also provides details on performance, installation, and maintenance requirements.

It is available for downloading (at no cost) at:
http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/ctrl?action=shwart&index=an&req=5758169&lang=en

For further information, contact Noureddine Benichou at (613) 993-7229, or *noureddine.benichou@nrc-cnrc.gc.ca*

The research leading to the publication of this guide was jointly funded by the National Research Council Canada and Public Works and Government Services Canada.

Class Action Lawsuit Against USGBC

A class action lawsuit has been launched against the US Green Building Council and its LEED program.

The allegations are essentially fraud and false advertising. It is alleged that the USGBC has falsely claimed that its rating system makes buildings save energy, that building owners have spent more money to have their buildings certified, that professionals have received worthless professional credentials and people in general have been duped into thinking LEED has meaning.

The heart of the case focuses on the energy criteria of the certification. The energy portion of the certification has been based on energy modelling that compares the building design against the ASHRAE 90.1 standard. When assumptions differ from the actual use of the building, the performance of the building will differ from the design analysis.

Changes are being made to the LEED standard to require a more stringent review of commissioning and post occupancy monitoring to ensure the building meets design intentions.

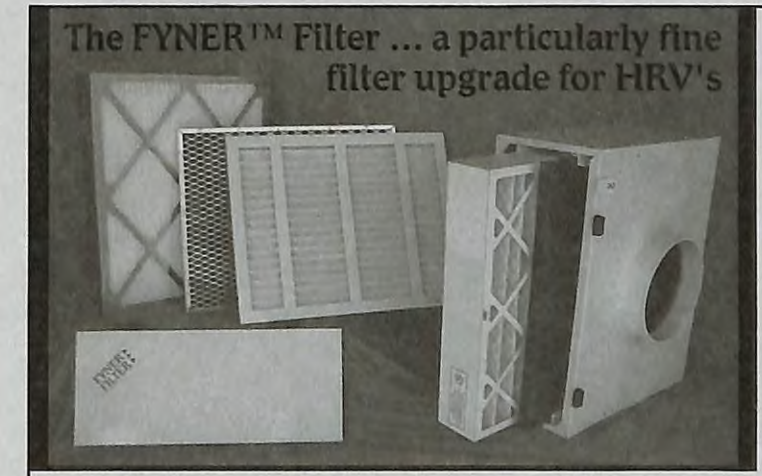
Lawsuit Implications

This lawsuit points to is the importance of understanding what is at the core of these voluntary standards, and being certain that the programs are not being oversold.

A number of professional associations and insurers have issued warnings about claims being made for green buildings. Overly optimistic claims open the door for problems when expectations are not met for a number of reasons.

In the residential sector, the LEED Canada for Homes Rating has been criticized for not being aggressive enough in their energy performance requirements. Regrettably, Canada Green Building Council (CaGBC) marketing still talks about LEED homes having lower energy bills, which is not necessarily the case. The minimum required for compliance is an EnerGuide rating of 76, which is less than code requirements in several Canadian jurisdictions.

The moral of the story: be careful what you promise, and be sure you deliver on it.



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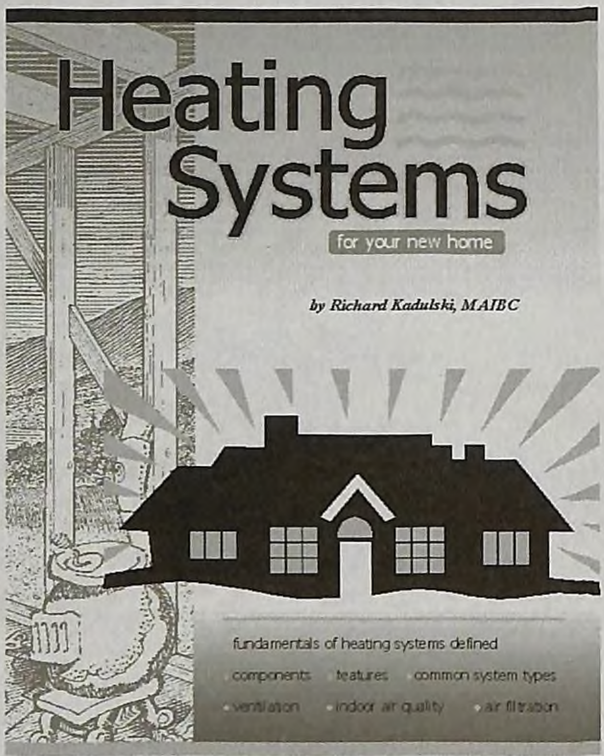

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